IMPACT-RESISTANT CASE WITH SEALABLE OPENING

FIELD OF THE INVENTION

The present invention relates to an impact-resistant case with a sealable opening, in particularly to a dust and watertight seal.

BACKGROUND OF THE INVENTION

Electronic enclosures and housings are basically cases designed to provide protection for product contents. Aesthetics, ergonomics, weight, decoration, and additional functionality are provided as well since the case is usually the basis of human interface to the product. This interface may be sensory (visual) only, or it may be the basis for product use - e.g. the user holds onto the package to use the product. For example, a portable drill where the case is also the tool housing and the housing is what the operator holds to use the tool. Consequently, the case is a multifunctional product in its own right and the design is the result of fulfilling all the necessary functional requirements.

Recent developments in portable electronics has resulted in the need for ruggedized supplemental cases for electronic products, such as web tablets, cell phones, video and still cameras, palm computers, etc. These specialized secondary enclosures allow products designed for office use to be usable in the outdoors under adverse conditions. There are numerous hazards for which a protective case may be required, two primary ones being impact (drop) and environmental (water and/or dust). Challenges arise when the protection functionality is combined with aesthetics or ergonomics.

Traditionally, a shipping case is designed to be energy absorbent. If energy absorbency is the only requirement, many low cost options exist since generally the larger the case, the easier it is to design it to be energy absorbent. For example, foam cubes can be placed in a corrugated box between the fragile contents and the box (case) and these blocks will provide a high degree of impact protection. However, this approach yields a large and bulky package. If in addition to impact resistance, the case needs to provide the "user interface", this approach is typically much larger than is practical and, on a sensory basis, it will appear as large, unwieldy, and even ugly. As a user interface enclosure, it's totally impractical. Consequently, user preferred supplemental enclosures are intensively designed to minimize size, bulk, weight, and optimize ergonomics.

Most portable electronic devices have features that require access while contained in a supplemental enclosure, for example, a protective case. For example, Personal Data Assistants (PDAs) have removable memory cards, batteries, synch cables, and/or power cables. However, under typical operating conditions, it may be desirable to use or access these features without removing the product from its protective case. In addition to the energy absorbing requirement, incorporating a functional requirement, such as access, traditionally has resulted in increasing the number of parts, the complexity to design and the cost to manufacture a protective case. When size, weight, protection, aesthetics, ergonomics, user access and/or more are all required, the protective case might end up with

as much or more engineering as the basic product itself. The conventional approach to this problem has been to tailor the design of the protective case for portable electronic device, unfortunately, this approach is time consuming and expensive.

An alternative, cost effective, approach to provide a protective case for portable electronic devices having multiple functions, such as impact-absorbing and internal access, is needed.

SUMMARY OF THE INVENTION

The present invention is a cost effective impact-absorbing insert which combines multiple functionality with parts consolidation and ease of customization that allows wide application anywhere tailored impact protection is desired. The impact-absorbing insert of the present invention mates with a user defined enclosure to produce a protective case for any fragile article that is used in a portable environment, for example portable electronic devices such as cameras (35 mm and digital), instrumentation, tools, PDAs, web tablets, hand held computers, cell phones, a pagers, gaming devices, electronic music players, voice recorders, global positioning systems (GPS), and the like.

It is further objective of the invention to reduce part count and to improve ease of use of the impact-absorbing insert.

It is a still another objective of the invention to provide versatility by designing an impact-absorbing insert which can fit into one or more different user defined enclosures. This reduces the level of complex engineering necessary for each product while allowing sophisticated design of the energy absorbing features in the insert alone.

In one embodiment, the present invention is an impact-absorbing insert for a protective case designed for containing and protecting a fragile article wherein the insert comprises one or more impact-absorbing portion and one or more tethered plug for insertion into an access tunnel contained in a mating user defined enclosure, wherein said access tunnel provides access to features of the article without opening the protective case.

In another embodiment, the present invention is a protective case for a fragile article comprising the impact-absorbing insert of the present invention and a user defined enclosure wherein the protective case provides impact protection and, when the access tunnel is plugged, a water tight and dust tight seal for the fragile article.

In another embodiment, the impact-absorbing insert comprises a molded polymeric material, preferably a low hardness, highly elastic polymeric material such as an elastomeric thermoplastic or an elastomeric thermoset plastic, preferably thermoplastic polyurethane.

Another embodiment of the invention is a method to retain the impact-absorbing insert in a user defined enclosure by designing attachment features which produce a tight fit between the impact-absorbing insert with the user defined enclosure, for example molded fingers on the impact-absorbing insert and grooves on the user defined enclosure, fingers on the user defined enclosure and grooves are on the impact-absorbing insert, or combinations thereof.

In a further embodiment of the invention the impact-absorbing portion of the impact-absorbing insert comprises one or more of an integral energy absorbing web and rib feature

that compresses or deforms to absorb impact loading, molded-in buttons, ribs, aesthetics features, engagement ribs, interference tolerances to enable positive fit and function for the life of the article, or combinations thereof.

It is still another embodiment of the invention to allow easy manufacture of the insert by utilizing common injection molding technology and tooling with open and shut operation.

Another embodiment of the invention is a protective case for a portable electronic device comprising the impact-absorbing insert of the invention inserted into a user defined enclosure which demonstrates an impact improvement provided to the user defined enclosure, and electronic product contained therein, sufficient to pass MIL-STD-810F, Table 516.5-Vi Transit Drop Test at a minimum of 24 inches.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an exploded perspective view from the inside of a protective case for a portable electronic device comprising an impact-absorbent insert and a mating user defined enclosure.

Fig. 2 is an exploded perspective view from the outside of a protective case for a portable electronic device comprising an impact-absorbent insert and a mating user defined enclosure.

Fig. 3 is an exploded perspective view of a web tablet with its protective case comprising an impact-absorbent insert and a mating user defined enclosure.

Fig. 4 is a perspective view of a protective case comprising an impact-absorbent insert and a mating user defined enclosure.

DETAILED DESCRIPTION OF THE INVENTION

The impact-absorbing insert **1** as shown in FIG. 1 has an outside surface **2** and an inside surface **3**. Further, the impact-absorbing insert has one or more impact-absorbing portions **4** and one or more tethered plugs **5**. At least a portion of the outside surface of the insert, for example the impact-absorbing section(s), is designed to fit within the exterior surface **21** of a user defined enclosure **20**. The user defined enclosure comprises a top portion **22** and a bottom portion **23**, each having an interior surface **24**. The user defined enclosure comprising the impact-absorbing insert comprise a protective case **30** for a portable electronic device **40** (Fig. 4).

Preferably, the outside surface of the impact-absorbing insert must fit tightly against the interior surface of the user defined enclosure. Any means to hold the insert tightly against the user defined enclosure is acceptable, for example, it can be held by an adhesive, a fastener, a mechanical means, or combination thereof. An example of a mechanical means is shown in Fig. 1. The insert is held by fingers **25** which are molded into the interior surface of the user defined enclosure which engage grooves **6** on the outside surface of the insert. Alternatively, the grooves can be on the interior surface of the user defined enclosure and the fingers on the outside surface of the insert or each surface can have one or more groove, one or more finger or any combination thereof.

When a portable electronic device is placed within the protective case, it must fit tightly against the inside surface of the impact-absorbing insert. The outside surface of the insert preferably has integral ribs and standoff features **7** that (1) provide clearance to prevent the portable electronic device from contacting the interior surfaces of the user defined enclosure, and/or the ground in a drop impact, and (2) absorb energy resulting from such a drop. Further, the impact-absorbing insert may comprise one or more molded-in button, rib, access tunnel, aesthetics feature, tethered plug, engagement rib, or interference tolerance to enable positive fit and function for the life of the product. Such features are designed for specific functionality based on the portable electronic device and end product needs.

Preferably, the impact-absorbing insert should have sufficient structure to avoid collapse in an impact situation and still be able to absorb the energy resulting from such a drop without damage to the portable electronic device it serves to protect. It is preferable that the insert has adequate flex fatigue resistance so as to recover its original position after being depressed when a drop or other impact occurs. It should be rigid enough to maintain its position within the user defined enclosure during normal use so as to minimize unwanted movement of the portable electronic device within the user defined enclosure.

Preferably, the impact-absorbing insert must have good solvent resistance and good long term creep properties so that it will not sag or warp over time. Further, it is preferable that the impact-absorbing insert have sufficient thermal resistance to enable it to perform its function in a wide range of climate conditions, preferably from - 40°F (-40°C) to 120°F (49°C). The enclosed portable electronic device may generate thermal issues as well and the impact-absorbing insert must withstand these without distortion or lack of performance.

As shown in FIG. 2, the tethered plug **5** is integral with the impact-absorbing portions of the impact-absorbing insert. It comprises a plug portion **9** and a tether portion **10**. The plug portion has an outside **11** and an inside surface **12**. The tethered plug is designed to initially pass through and then fit snugly back into an opening or access tunnel **26** in the user defined enclosure. The access tunnel allows access from the outside of the user defined enclosure/protective case to the portable electronic device located inside of the user defined enclosure/protective case without the need to open the user defined enclosure/protective case (for example to allow removal of a memory card, replace a battery, attach/detach a synch cable, insert/remove an earphone jack, insert/remove a power cable, etc.). The plug is designed to be insertable and removable from the outside surface of the user defined enclosure while remaining attached to the impact-absorbing portion(s) of the insert, which is on the inside surface of the user defined enclosure, by a tether that passes through the user defined enclosure opening. When the plug is inserted into the access tunnel, from the outside of the user defined enclosure, it preferably forms a water tight and/or dust tight seal. The impact-absorbing insert may have multiple tethered plugs for sealing matching multiple access tunnels in the user defined enclosure depending on the specific requirements of the portable electronic device which is incased within the protective case.

Preferably the impact-absorbing insert is molded with a nominal wall thickness equal to or greater than about 2 millimeter (mm) with integral feature (impact-absorbing portion,

tether, plug, etc.) thicknesses preferably equal to or greater than about 1mm, more preferably equal to or greater than about 1.5 mm and most preferably equal to or greater than about 2 mm. The maximum nominal wall and integral feature thicknesses are only limited by what is practical for the specific enclosure and portable electronic device, but generally, they are equal to or less than about 25 mm, preferably equal to or less than about 12 mm, and most preferably equal to or less than about 6 mm.

The impact-absorbing insert can be made from any polymeric material which can (1) be manufactured with the necessary geometric design and (2) will hold its shape through time in a wide range of environments when fitted into the user defined enclosure. Preferably, the polymeric material is a thermoplastic or thermoset elastomer. Suitable elastomers are described, for example, in Billmeyer, F., *Textbook of Polymer Science*, Interscience Publishers, New York, N.Y. (1965) and in *Kirk-Othmer Science of Chemical Technology* 4th Ed, John Wiley & Sons, New York, N.Y. (1993).

The impact-absorbing insert can be made from any elastomeric plastic, thermoplastic or thermoset with low modulus and high elasticity. Preferably, the impact-absorbing insert is made from a material having a hardness between about Shore 40 A to about Shore 65 D.

Preferably the insert is made from polyamide (PA); polyurethane (PU); polyolefin (PO), such as polyethylene (PE), such as low density polyethylene (LDPE), polypropylene (PP), ethylene and vinyl acetate copolymer (EVA), ethylene and propylene copolymer (EP), polyethylene and alpha-olefin co-polymer, such as ENGAGE™ polyolefin elastomers available from The Dow Chemical Company, thermoplastic polyolefin (TPO); polyvinyl chloride (PVC); polyester; polysiloxane; and mixtures thereof. Preferably the impact-absorbing insert is made from a thermoplastic polyurethane (TPU), such as PELLETHANE™ 2102-75A polyurethane available from The Dow Chemical Company.

The impact-absorbing insert of the present invention can be made by any known molding process including injection molding, transfer molding, reaction injection molding, or liquid injection molding.

EXAMPLE

The following example serves to demonstrate an embodiment of the invention but is not intended to limit the scope of the invention.

PELLETHANE 2102-75A thermoplastic polyurethane resin is injection molded into a designed geometry mold cavity in the shape of an impact-absorbing insert measuring 218 mm x 30 mm x 37 mm with a nominal wall thickness of 2 mm. This design is the result of combining the fit functionality between a portable electronic device, a user defined enclosure having two access tunnels, and an impact-absorbing insert with the energy absorbing features (ribs, standoffs, and fingers) and two tethered plugs for the access tunnels. All the geometry necessary for correct functionality is designed into the part and transferred to the metal mold, which reproduces the requisite geometry to all parts manufactured by it. The manufacture of the part is such that each time the mold opens, a complete, impact-absorbing insert is ejected. The impact-absorbing insert contains the necessary impact absorption features and tethered plugs all in one molded article.

The PELLETHANE 2102-75A TPU resin is dried at a temperature between 80°C to 95°C and the molding conditions are a melt temperature between 200°C to 215°C with a mold temperature between 15°C to 60°C. An Engel 25mm single screw injection molding machine is used.

The resulting impact insert is placed into a user defined enclosure (also molded from PELLETHANE 2102-75A TPU resin) having a top and bottom portion, such that the impact-absorbing insert is placed in the top portion and mates with a recess in the top portion of the protective user defined enclosure. A personal electronic device, for example a web tablet, is placed in the protective user defined enclosure and fits snuggly against the impact-absorbing insert. The access tunnels in the user defined enclosure line up with the access features of the electronic device and when the tethered plugs on the impact-absorbing insert are inserted into these access tunnels a water and dust tight seal is formed.

The top portion of the user defined enclosure is mated with the bottom portion of the user defined enclosure. The resulting protective case provides the encased portable electronic device water and dust resistance, impact protection, and access to features within the user defined enclosure.

The protective case comprising a portable electronic device, the user defined enclosure, and the impact-absorbing insert is subjected to the MIL-STD-810F, Table 516.5-VI Transit Drop Test and passes at a minimum of 24 inches.

Table 516.5-VI testing protocol is:

- To pass, the unit must survive 26 drops at a specific height without damage (defined as impaired functional use) to the portable electronic device.
- Up to five units may be used to obtain the 26 drops.
- Use five different units for each drop height (24 in. (70 cm), 30 in. (76 cm), 36 in. (91 cm), 42 in. (107 cm), 48 in. (122 cm), etc.)
- The units are dropped onto concrete covered with two layers of 0.5 inch plywood.
- Drop Sequence:

  1. Drop on each of the 6 faces 3 times (18 drops total). Evenly spread these drops over 3 units.
  2. Drop on each of the 4 corners 2 times (8 drops total).
  3. Repeat at next drop level if 26 passing drops are achieved.

As can be seen by the preceding example, the present invention provides a cost effective impact-absorbing insert which combines multiple functionality with parts consolidation and ease of customization that provides good impact protection to the encased portable electronic device.